REMARKS

The examiner has made a species restriction requirement.

Applicants have amended the claims to focus on the axicon aspect of the invention, which had been claimed in original claims 16-28. New independent claim 29 is directed to light collection optical elements for a bar code scanner, in which the light connection elements include a collection lens positioned to collect light reflected from a bar code symbol and to direct the light to a light sensing element, and in which the collection lens includes an axicon element shaped and positioned to extend the working range over which the bar code symbol can be resolved by the sensing element. Dependent claims 17-28 have been amended for consistency with new claim 29. New dependent claims 30-31 have been added.

Fig. 8 is chosen as the elected species. All pending claims are believed to cover Fig. 8, as the specific optical properties of the axicon and lens are at a level of detail not shown with particularity in the figure.

The species restriction is not traversed.

Attached is a marked-up version of the changes being made by the current amendment.

Applicant asks that all claims be allowed. Enclosed is a $110 check for the Petition for Extension of Time fee. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 5/10/01

G. Roger Lee
Reg. No. 28,963

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

Version with markings to show changes made

In the specification:

Paragraph beginning at page 1, line 29 has been amended as follows:

Summary of the Invention

The invention provides light collection optical elements for a bar code scanner, in which the light connection elements include a collection lens positioned to collect light reflected from a bar code symbol and to direct the light to a light sensing element, and in which the collection lens includes an axicon element shaped and positioned to extend the working range over which the bar code symbol can be resolved by the sensing element.

[The invention provides an athermalized plastic lens in which optothermal changes are balanced by refractive and diffractive optics, allowing the lens to achieve thermal performance characteristics similar to those of a glass lens, while being inexpensive, lightweight, and easily shaped. When the lens includes an axicon, the lens provides equipment such as bar code scanners with an extended working range.

Preferred implementations of the invention may include one or more of the following. The lens may include a refractive surface and a diffractive optical element, wherein optothermal changes due to the refractive surface counter optothermal changes due to the diffractive optical element. The optothermal changes may cancel each other and include changes affecting the focal length of the lens. The lens may include polycarbonate. The lens may include acrylic. The lens may include a net positive power. The optothermal expansion coefficient of the refractive optical apparatus may be higher than an optothermal expansion coefficient of the diffractive optical apparatus. The lens may include a diffractive optical element that is substantially smaller than the lens. The first surface of the lens may provide substantially all of the negative power of the lens, and the second surface of the lens may provide substantially all of the positive power of the lens. The surface of the lens may provide substantially all of the negative power of the lens and substantially all of the positive power of the lens. The diffractive optical apparatus may include a diffractive optical element that is substantially spherical in

average. The surface of the lens may be substantially flat. The refractive optical apparatus may be divided unevenly between first and second surfaces of the lens. Substantially all of the diffractive optical apparatus may be disposed on one surface of the lens. The diffractive optical apparatus may be divided substantially evenly between first and second surfaces of the lens. The lens may include an axicon.] The axicon may include a polymer. The axicon may be disposed at a substantially spherical surface of the lens. The diffractive optical element and the axicon may be disposed at different surfaces of the lens. The lens may include a diffractive optical element that includes at least eight phase levels. The lens may include a diffractive optical element that includes fewer than nine phase levels. The axicon may be affixed to a surface of the lens. The lens may include an aspherical surface having the optical properties of a combination of a spherical surface with the axicon. The lens may include a doublet. The lens may include a Cook triplet anastigmat. The lens may include a symmetric double Gaussian. The MTF of the lens may be higher with the axicon than without the axicon for bar code symbols having spatial wavelengths of 10-20 mils, inclusive. The MTF of the lens may be at least 0.2 for a 10 mil bar code symbol that is from about 4 to about 16 inches away from the lens. The light collection optical elements may include a moving element (e.g., a CCD device).

In the claims:

Claims 1-15 have been cancelled.

Claims 17-28 have been amended as follows:

17. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the axicon includes a polymer.

18. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the axicon is disposed at a substantially spherical surface of the lens.

19. (Amended) The [lens] light collection optical elements of claim [1]29, wherein a diffractive optical element and the axicon are disposed at different surfaces of the lens.

20. (Amended) The [lens] light collection optical elements of claim [1]29, comprising a diffractive optical element that includes at least eight phase levels.

21. (Amended) The [lens] light collection optical elements of claim [1]29, comprising a diffractive optical element that includes fewer than nine phase levels.

22. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the axicon is affixed to a surface of the lens.

23. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the lens has an aspherical surface having the optical properties of a combination of a spherical surface with the axicon.

24. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the lens includes a doublet.

25. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the lens includes a Cook triplet anastigmat.

26. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the lens includes a symmetric double Gaussian.

27. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the MTF of the lens is higher with the axicon than without the axicon for bar code symbols having spatial wavelengths of 10-20 mils, inclusive.

28. (Amended) The [lens] light collection optical elements of claim [1]29, wherein the MTF of the lens is at least 0.2 for a 10 mil bar code symbol that is from about 4 to about 16 inches away from the lens.

In the abstract:

[A plastic lens includes refractive and diffractive optical apparatus configured to produce optothermal changes substantially canceling each other over a predetermined working temperature range to render the plastic lens substantially athermalized over the range.] Light collection optical elements for a bar code scanner, in which the light connection elements include a collection lens positioned to collect light reflected from a bar code symbol and to direct the light to a light sensing element, and in which the collection lens includes an axicon element shaped and positioned to extend the working range over which the bar code symbol can be resolved by the sensing element.